

## FUEL CELL VEHICLES RUN ON HYDROGEN...

### *Where Do We Get Hydrogen?*

For a fuel cell to operate, it needs hydrogen as its fuel. Fed into the fuel cell along with oxygen, electricity can be made to power the vehicle's engine.

Getting oxygen for a fuel cell is relatively easy. We get it from the air all around us. Oxygen makes up about 20% of the air that we breathe.

Getting hydrogen is more complicated, even though it, too, is all around us.

Hydrogen is *the most* abundant element in the universe. In nature, however, it usually is not found alone. Instead, it bonds readily with certain other elements, forming commonly known molecules, like water, and a host of substances like gasoline, natural gas and methanol. We can get hydrogen by unlocking the chemical bonds in the molecules that form these substances.

### HYDROGEN FROM WATER

When two hydrogen atoms bond with an oxygen atom, they form water,  $\text{H}_2\text{O}$ . One way to produce hydrogen is to use energy to break water apart, through a process called electrolysis. In this process, electricity and a catalyst are used to separate the hydrogen from the oxygen in the water.

Hydrogen released from water by electrolysis can be captured and used as fuel for a fuel cell. After it is collected, it is either compressed into a high-pressure gas, or cooled into a liquid and pumped into the vehicle's fuel tank for use on-board the car or bus. What happens to the oxygen? It can either be captured or released into the air.

### HYDROGEN FROM HYDROCARBON FUELS

Other sources of hydrogen include hydrocarbon fuels. For example:

Natural gas	$\text{CH}_4$	Gasoline	$\text{C}_8\text{H}_{18}$
Methanol	$\text{CH}_3\text{OH}$	Ethanol	$\text{C}_2\text{H}_5\text{OH}$

These fuels can be processed, or "reformed," to extract the hydrogen so it can be used in a fuel cell. In the methane steam reforming process (see below), half of the hydrogen comes from water, and the rest comes from natural gas.

Currently, large volumes of hydrogen are produced for industrial use (over eight million tons a year in the U.S.). Most of it is made from natural gas through a process called steam reforming. This is one source of hydrogen used to fuel prototype fuel cell vehicles today.



Hydrogen for fuel cell vehicles can also be produced from a liquid hydrocarbon fuel like methanol or gasoline. A fuel processor reforms the liquid hydrocarbon fuel, separating out the hydrogen, which is then delivered to the fuel cell. The reforming process can take place on board the vehicle or at the fueling station.

### ***“Where Will I Fill Up My Fuel Cell Car?”***

Gas stations are a familiar site for our conventional, internal combustion engine vehicles – they are located nearly everywhere we drive. For fuel cell vehicles to be successful, they also will need a convenient, safe fueling system.

Today, fuel cell fueling stations don’t exist, except for a few prototype facilities put into service for R&D purposes by the California Fuel Cell Partnership and others.

In the future, when you drive your fuel cell vehicle, the gas station you currently use may be the place where you’ll get hydrogen...or perhaps methanol...or a new grade of gasoline. All of these fuels and more are being considered and tested as fuels for fuel cell vehicles.

Developing the infrastructure for producing and distributing the fuel for fuel cell vehicles is a major task, and there are many questions and challenges to be addressed. Through the CaFCP, the auto companies, energy suppliers, technology companies and government agencies are working together to thoroughly investigate all the fueling options, and to test them in real-world conditions.

### **FOR MORE INFORMATION**

If you’d like to learn more about the fueling options for fuel cell vehicles, visit [www.cafcp.org](http://www.cafcp.org).

#### ***A Few of the Basics...***

Fuel cells generate electricity, using hydrogen as their fuel in an electrochemical process. A fuel cell can be used, in combination with an electric motor, to drive a vehicle – quietly, powerfully and cleanly.

When operating directly with hydrogen, there are no polluting emissions from a fuel cell, only water and heat.

Depending on how the hydrogen for a fuel cell is produced – for example, from hydrocarbon fuels, or through electrolysis of water using electricity generated from fossil fuels – there can be some pollutants associated with the fuel production. If the hydrogen is generated from renewable resources, like solar or wind-generated electricity for use in electrolysis, then the entire system is pollution-free and renewable. Although there are pros and cons with each of these methods, they are all being carefully considered and developed.

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